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USTULINA ZONATA ON HEVEA BRASILIENSIS.

Preliminary report on further work.

A. SHARPLES.

A description of *Ustulina Zonata*, (Lev) Sacc: with an account of its method of attacking *Hevea Brasiliensis* at the collar is given by Brooks in Bull. No. 22, issued by the Department of Agriculture—F. M. S. This account includes the results of investigations made up to the end of 1914, when the author left the F. M. S. for England. During the current year 1915 much information has been obtained about this fungus as a pest on *Hevea Brasiliensis* in the F. M. S, and the facts brought to light warrant a detailed presentation.

Rubber trees attacked by *Ustulina Zonata* were first noticed by this Department early in 1913. It was not till the middle of 1914 that Brooks discovered the fruit bodies which enabled him to identify the fungus causing the disease. This fungus, however, has been at work for many years, for a manager of an estate in Johore writes to the Department as follows:—"This disease was first noticed on our property in 1907 in a $4\frac{1}{2}$ acre block of 8 year old rubber, planted in rich swamp land 9' x 9' then badly drained. It killed six trees or so but in this block no further cases have occurred during the last six years. On another block of trees, aged 11 years, planted 18' x 18' in very old flat land, there are some thirty 16 year old trees interspersed and for some years now we have lost two or three trees annually from this disease which generally attacked these 16 year old trees, but has also killed two or three of the younger ones at different times." This letter is interesting in view of the nature of the attack on rubber trees. Referring to the publication by Brooks, the fungus is described as

simply causing a root and collar disease in rubber trees. His observations agree with those of the manager whose letter is quoted above and he says:—"Some of the finest specimens of rubber trees 14-16 year old have succumbed to this root attack, only few trees of from 4-6 years old show in the disease in an advanced stage. As the fungus progresses in the collar and root systems of the tree the foliage becomes thin and the branches commence to die back; the tree gradually dies unless successfully treated in an early stage of attack."

The symptoms shown by a tree attacked by this fungus are very characteristic. Such a tree will show a noticeably thin crown of leaves and if the roots are opened up, usually one side of the wood of the stem at the collar will be found to be dry and tindery, very much like touchwood. The other side of the stem may be healthy and often gives a good yield of latex. If the diseased side is cut open with an axe, conspicuous black lines will be found running irregularly through the tindery wood; they often form black circles of varying diameter. The dry, tindery nature of the wood and the presence of black lines render it impossible to mistake trees killed by *Ustulina Zonata*. It may be pointed out that numerous fungi besides *Ustulina Zonata* produce black lines in the roots of rubber trees in which they are working. These fungi however, never cause the same dry tinder wood, and seldom are lines produced by them so conspicuous and irregular.

Judging from inoculation experiments the fungus appears to be a wound-parasite, *i.e.* it can only enter the tree through a wounded surface. Observations in the field lead to the conviction that infection in the majority of cases takes place through wounds in exposed lateral roots. In most plantations, the lateral roots of the trees are exposed at some point or other and these roots are very liable to injury. The fungus enters the wounded places and passes towards the collar in a most peculiar manner, *i.e.* up the middle of the root. Thus if the exterior of such a lateral root is examined it appears healthy and it is not till the root is cut clean through that the diseased portion is observed. Due to this insidious method of progress even suspected lateral roots may escape detection, for they appear quite sound judging from external appearances.

This short account of the workings of *Ustulina Zonata* in the root and collar system has been given as a guide to other phases in connection with the relation of this fungus and *Hevea Brasiliensis*, for it functions not only as a dangerous root disease on old rubber, but causes serious losses in the plantations when thin-

ning out is taking place. Not only so, the root attack on old trees is probably largely dependent on the workings of the fungus at the time when thinning-out is in progress. This point is of great importance, for the health of old rubber will depend largely on the treatment adopted when plantations are thinning-out.

In the Federated Malay States thinning-out on plantations is usually undertaken when the trees are 6-7 years old. It is a matter of common experience that during this process, attacks by boring beetles become prevalent. This is partly due to the trees cut out forming a suitable breeding place for the insects, but other factors contribute. Numerous visits to estates were made to try to find an explanation for these attacks and it was not till the beginning of the year (1915) that any evidence was obtained. Then a specimen showing the beginning of the borer attack was obtained and sections showed that the borers were actively penetrating a dry rotten portion of the stem, commencing some 4' from the ground and extending some 10' up to the first fork. The tree was quite healthy except for this portion confined to one side of the stem. In this affected part, black lines similar to the characteristic ones found in the collar of a rubber tree attacked by *Ustulina Zonata* were observed. The dry tindery wood of this portion was also typical.

The same fungus was isolated both from the rotting wood of the stem and from the black lines. These are due to the attack of one fungus. The boreholes made by the insects were filled with a white mycelium, and from small pieces of this mycelium the same fungus as that from the rotten wood and black lines was obtained in pure culture.

Pure cultures of *Ustulina Zonata* (Lev) Sacc, from affected roots of rubber had already been established. The zoning in these cultures was very characteristic. In the cultures obtained from the stem of the tree attacked by borers this zoning was absent, though similar in every other respect. On a neighbouring tree much worse affected, typical specimens of the fruit body of a sp. of *Ustulina* were obtained from the trunk, some 8 feet from the ground. Sections of this stem showed the same characteristic symptoms as the tree described above. The fruit-bodies, however, showed the typical conidial layer described by Petch for *Ustulina Zonata*, but which Brooks had not observed up to the time of his departure. The absence of the typical zoning in the cultures obtained from the stem and the presence of the conidial layer rendered necessary critical cultural experiments to decide whether there were two distinct species of *Ustulina*, one

causing the root disease and another species which could cause a rotting of the stem in association with boring beetles. These experiments will be described in detail later but now it is sufficient to say they proved that *Ustulina Zonata* was the fungus growing in the rotten wood of the stem through which the borers were penetrating. It may be also mentioned here that the fruit-bodies of *Ustulina Zonata* have been found to be fairly common on the stems of rubber trees attacked by borers.

Ustulina Zonata is practically always found in trees attacked by boring beetles. During the year several estates have been troubled with leaf fires, and the bark of large numbers of trees up to a height of 8 to 10 feet was scorched. Especially on one estate where a solid 9 acre block of 9 year old trees had to be cut out, the association between the borers and the fungus was very evident. All the scorched trees were attacked by boring beetles, and in every case the typical symptoms of *Ustulina Zonata* were found in the wood. Two or three days were spent in an endeavour to find trees showing the fungus attack only; this endeavour was unsuccessful. Several cases were noted where the fungus was active and only three or four bore-holes could be found. No case was observed where it could be stated that the fungus alone was working in the tissues—i.e., in every case traces of borer were found. In every scorched tree examined on these estates the association of the borer and the fungus was pronounced; the fungus was isolated in several cases, and obtained in pure culture.

An experiment (2) recently performed by the writer brought forward further evidence to support the association of *Ustulina Zonata* and borer attacks. The experiments were designed to test the effect of bark—scraping on rubber trees, with a view to find evidence as to whether such treatment rendered the trees more liable to insect and fungus attack. Within a week from the beginning of the experiment three trees were attacked by borer and of these trees, two quickly showed *Ustulina Zonata* in the bark and wood. On one tree a beautiful case is progressing and daily observations on the progress of the fungus have been made. An interesting feature in this case is that after establishing themselves in the trees the insects disappeared after the first fortnight and the fungus alone is now attacking the stem. Thus a direct comparison of the fungus in the root and stem will be possible after a few months.

As shown by a previous experiment* it has been proved that the outer corky cells i.e., the true bark, forms the important

* Bark Scraping and Bark affection: Ag. Bull. F. M. S. Aug. 1915. Vol. III No. II.

protective layer, and once this corky layer is injured a tree is liable to be attacked by borers. In thinning out, a tree is felled and it is certain to come into contact with neighbouring trees during its fall. The bark of these trees is injured and boring beetles entre, and the fungus, *Ustulina Zonata*, quickly follows them. The tree dies quickly owing to the combined attack, and it is either cut down or allowed to stand as the case may be. The flat and plate-like fruit-bodies develop on the exterior; these have been found commonly on dead trees still standing and on cut-out trees lying on the ground.

Experiments in the laboratory show that a greyish-green conidial layer is first produced on the fruit body. These spores or conidia are produced in a very prolific manner. In the laboratory this stage persists for some 5 or 7 days. During this period in the field, a tremendous number of spores are liberated and blown by the wind. Any insect—i.e. white-ants, red ants, borers, etc. walking over the fruit-body during this period would carry away large number of spores attached to its appendages. It is easy to see how dangerous it is to old rubber to allow these fruit bodies to develop and fructify at the time thinning out is in progress for by the agencies enumerated above the spores may be carried to wounds in the roots of neighbouring trees. The spores germinate and ultimately the fungus works into the collar. Its activities in the collar are noticed when the tree beings to look thin in the crown; if the roots are opened up the cause is obvious, but then it is usually too late to try to apply a remedy.

The study of this disease shows an interesting correlated series of events. The association of the fungus with borers results in rubber trees being permeated with the hyphae of *Ustulina Zonata* when thinning-out is in progress. On these trees the fruit bodies of the fungus develop, and from these spores are carried by various aegencies to roots of healthy trees which they are capable of infecting through wounds. The wood in the infected roots becomes dry and tindery and so favourable for easy penetration by white ants. A large number of the roots of old rubber trees attacked by this fungus show the centre hollowed out by these insects.

There is evidence to show that the disease may originate from old jungle stumps left in the plantation after clearing. Fruit-bodies have been obtained on several occasions from such old stumps. In young plantations being treated for *Fomes*, similar black lines to the ones characteristic of this fungus have been observed in the lateral roots of huge jungle trees, and if these were

left standing, there is no doubt that infection of rubber roots would take place if they came in contact with roots infected with *Ustulina Zonata*. Another case has been observed when a rubber stump left in the ground after thinning-out developed this fungus, and two neighbouring rubber trees, whose lateral roots were in contact had to be cut out because the fungus had passed from the stump along the lateral roots into the collar of the rubber trees.

The investigation of this disease on rubber emphasises the necessity of absolute cleanliness as a matter of estate routine. When the majority of plantations reach the age of 10-15 years, the number of trees to the acre will be considerably below 100, and a yearly loss of three or four trees in an acre directly affects production over this area. On the majority of estates little thought is given to the possibility of disease in the future. The idea appears to be prevalent that if trees escape attack by *Fomes semitostus*, or if "Pink Disease" does not become troublesome, there is little cause for worry as regards disease, for magnificent 15 years old trees will certainly be more resistant than younger ones. Such may be the case, but care is necessary, for as time goes on there is little doubt that other fungi will find *Hevea brasiliensis* a suitable host. It is certain that strict attention must be given to methods of plant sanitation if the future of the rubber plantations in the F. M. S. is to be ensured; the fact that the trees have successfully passed the 10 year old stage should encourage planters to see that they emerge successfully 10 or even 20 years later. Root diseases are likely to prove most troublesome for even if "Pink Disease" affects an estate badly, preventive measures can be undertaken and the trees are not wholly lost. Root diseases, especially those likely to affect old trees are so insidious that they are seldom noticed until too late, and the trees are entirely lost. More especially with reference to *Ustulina Zonata*, planters should begin to pay more attention to sanitation methods on the plantation, in order to guard the old trees. In Malaya the root disease caused by *Ustulina Zonata* is likely to prove the most serious trouble on plantations which have reached an age of more than 10 years. On one old plantation, a large number of trees 10-12 years old, suspected of root-disease were opened up at the roots and over 100 trees were found to be suffering from root trouble. In a large percentage of cases the trouble was due to *Ustulina Zonata* while the cause of the trouble in the remainder was probably a fungus under investigation at the present time by the Asst. Mycologist. Occasionally trees were found in which both these fungi were present. It is certain that these two fungi are capable of destroying whole fields of old rubber between them.

Previous to this investigation it was doubtful whether a thorough clearing of jungle stumps and rotting timber on young estates would pay in the long run. In certain "Fomes" districts the money would certainly have been well spent, but now the trouble caused by *Ustulina Zonata* is understood it is equally certain that a thorough clearing of estates either before or immediately after planting up will be fully recompensed. Again after thinning-out, the stumps should be taken out immediately to minimise the chances of the fungus developing. When trees are badly attacked by borers, they should be cut out immediately and destroyed as quickly as possible. All measures tending towards cleanliness on the plantation will minimise the danger to be anticipated from attacks by this fungus, and the insects associated with it *i.e.*, borers and white ants.

As regards treatment of the old trees attacked at the collar experiments will be carried out with a view to saving all except very badly affected trees. The diseased wood is usually confined to one side of the collar. If this diseased portion can be thoroughly cut out and in its place a pillar of reinforced concrete be supplied, one side of the tree will be saved and from such an old tree, a large amount of latex is usually obtained. A renewal of 4 years can be allowed for by means of a single cut, and under these conditions the tree ought to thrive, and give a good return for the money expended in treatment. Trees too badly affected for such treatment will have to be taken out and destroyed.

It must be strongly emphasised with respect to the trouble caused by *Ustulina Zonata* that planters have the remedy in their own hands. It is not too late on the majority of plantations to commence sanitation work in order to prevent this fungus propagating itself. The important points to be observed are (1) clearing up of the land as soon as possible after planting up, special attention being given to the treatment of the old jungle stumps. (2) during thinning out, all trees cut, stumps especially, should be cleared quickly from the plantation, special attention being given to trees, felled or standing, which become attacked by borers. If attention is paid to these points the danger of *Ustulina Zonata* causing trouble on the plantations in the future will be considerably minimised. But an endeavour should be made to get acquainted with the fruit-bodies of the fungus so that these may be destroyed immediately they make their appearance. A fully illustrated bulletin will be issued as soon as possible and this will be further supplemented by lectures to planting associations when typical specimens will be exhibited. Planters whose business

brings them to Kuala Lumpur need not wait for the lectures to see the specimens. The Officers in the Department are always pleased to give any information they can, and any one who visits the Mycological Laboratory can see typical specimens and have them explained.

I wish to acknowledge my indebtedness to all planters who have forwarded specimens to the Laboratory for examination. Messrs. W. S. Reeve-Tucker and J. Anderson of Sungei Way Estate, C. K. Cox of Klabang Estate, Perak, Mr. J. Whyte—Elphil Estate, Perak. Mr. E. W. King of Kuala Lumpur, I have to thank for help and information at various times.

Manurial Experiments with Young Rubber at Kuala Lumpur.

Fourth Year's Result.

BY F. G. SPRING.

Descriptions of these experiments were published in the Agricultural Bulletin F. M. S. Vol. 1, page 194, Vol. II, page 88 and Vol. III, page 9, and the results for the first, second, and third year were then given. Before considering the fourth year figures it would perhaps be as well, for convenience sake, to give a few particulars which have been published in the previous articles. The land on which the tests were made is not ideal for manurial experiments. It was necessary to divide the plots into two sections, namely A and B, as there was not a sufficiently large area of one description of land to carry out the required number of experiments.

The nature of the soil is laterite and would appear to be below the average as regards soil fertility.

Plot A is fairly flat but B, is sloping, a disadvantage in experiments of this nature as there is a tendency for manures to be washed from one plot to another.

The land was weeded once in six weeks, the control plots being weeded as often and treated in a similar way to the manured as regards cultivation.

In the first application the manures were forked lightly in around the young trees to a depth of 2 to 3 inches, between two

circles of 1 and 4 feet radius, the tree being the centre of the circle. At the time of the second application the trees were two years older in view of which the fertilizers were spread broadcast all over the soil and lightly forked under.

Quick lime was used in each case, the lumps being distributed throughout the fields and allowed to slake naturally. The lumps soon became reduced to a fine powder and it was found easy to distribute. One night's rain is sufficient for this decomposition to take place but in dry weather it may take several days.

Full particulars as to quantities of manures and dates of application, girth, and number of trees, etc., are given in the tables.

In reviewing the results for the four years it is noticeable that during the first year, the trees in the manured plots, in every case, showed a good excess in girth measurements over the trees in the unmanured plots. In the second year, there was no manure applied, and reference to the tables will show that the average girth increases, for this period, are about equal to that of the control plots which goes to prove that the manures had good effect for one year only. At the commencement of the third year, a second application of similar manures was applied, and the results for this year show that in one block of land (Table A), the trees in the manured plots, have, in each case, an excess in girth measurement over trees of the unmanured plot but not as large an excess as was evident the first year. In the other block of land (Table B) there is no appreciable difference, in the third year, between the average girth increases of the manured plots and the control. As the quantities of manures in both applications were equal it would be expected that better results would be obtained with the first application as the manures were more concentrated in the root feeding area.

In the fourth year, no fertilizers were applied, and it will be seen that the manured plots have not given as large an average girth increase as the control plots, in fact there is a distinct falling off in girth increase as compared with them for this year.

In this particular soil, the fertilizers appear to have had a stimulating effect, as regards growth, after each application, for about one year but afterwards there seems to be a slight reaction.

Although over the period of four years the total increases in the manured plots in every case, exceed that of the controls, as shown in the tables, it would be impossible to say to what extent the fertilizers have been profitable, this can only be shown by yields of latex. The trees are shortly to be tapped and in future, results will be based on yields of rubber.

In previous reports, on this experiment, the number of trees stated is 120 but owing to a quantity having to be cut out, through various reasons, the number in each plot was reduced to 100 at the commencement of the 4th year but as the results are based on average girth increase this does not affect the experiment.

TABLE A.

Plot.	Fertilizer added.	Total increase over a period of 4 years.	Excess over control plot for a period of 4 years.
1.	Sulphate of Ammonia, Double Superphosphate, Lime.	23.21 inches.	2.47 inches.
2.	Sulphate of Ammonia, Lime.	23.69 ,,	2.95 ,,
3.	Sulphate of Ammonia, Double Super. Sulphate of Potash, Lime.	24.28 ,,	3.54 ,,
4.	Sulphate of Ammonia, Sulphate of Potash, Lime.	21.55 ,,	0.81 ,,
5.	Double Superphosphate, Sulphate of Potash, Lime.	22.11 ,,	1.37 ,,
6.	No Manure.	20.74 ,,	

TABLE B.

7.	Sulphate of Potash, Lime.	22.52 ,,	1.38 ,,
8.	Double Superphosphate, Lime.	22.68 ,,	1.54 ,,
9.	Lime.	22.22 ,,	1.08 ,,
10.	Perlis Guano.	22.67 ,,	1.53 ,,
11.	Bone meal.	23.19 ,,	2.05 ,,
12.	Sulphate of Ammonia, Double Superphosphate, Sulphate of Potash,	22.80 ,,	1.66 ,,
13.	No Manure.	21.14 ,,	

No. of Plot.	Fertilizer added.	Excess increase in girth over trees of the unmanured plots.			
		1st Year	2nd Year.	3rd Year.	4th Year.
2.	Lime, Nitrogen	1.36 inches.	0.19 inches.	0.98 inches.	0.42 inches.
4.	Lime, Nitrogen, Potash ...	1.23 "	0.04 "	0.54 "	-1.00 "
1.	Lime, Nitrogen, Phosphate ..	1.87 "	0.28 "	1.66 "	-1.34 "
5.	Lime, Potash, Phosphate ..	1.87 "	0.51 "	0.83 "	-1.81 "
3.	Lime, Potash, Phosphate, Nitrogen	2.35 "	-0.01 "	1.53 "	-0.33 "
9.	Lime	1.05 "	-0.58 "	0.30 "	0.31 "
7.	Lime, Potash	1.12 "	0.24 "	0.20 "	-0.18 "
8.	Lime, Phosphate	1.87 "	0.26 "	-0.16 "	-0.43 "
12.	Phosphate, Potash, Nitrogen ..	1.48 "	0.15 "	-0.30 "	0.33 "
		Manured.	No manure applied.	Manured.	No manure applied.

TABLE A.
No. of trees in each plot, 100.

No. of Plot.	Manure applied.	Date of applying manure 1st application.	Date of applying manure 2nd application.	Average girth 1 foot from the ground.				Increase in girth.			
								1st year 2nd year 3rd year 4th year.			
1	Sulphate of Ammonia Double Superphosphate Lime.	14 Nov. 1911 16 Nov. 1911 21 Sept. 1911	30 Dec. 1913 31 Dec. 1913 14 Oct. 1913	2'33 ins 7'00 ins Oct. 1911	11'05 ins 18'14 ins Oct. 1912	25'56 ins 4'65 ins Oct. 1913	4'05 ins. 7'09 ins. Oct. 1914	7'42 ins.			
2	Sulphate of Ammonia Lime.	15 Nov. 1911 21 Sept. 1911	30 Dec. 1913 14 Oct. 1913	1'90 ins 6'04 ins Oct. 1911	10'00 ins 16'41 ins Oct. 1912	25'59 ins 4'14 ins Oct. 1913	3'96 ins. 6'41 ins. Oct. 1914	9'18 ins.			
3	Sulphate of Ammonia Double Superphosphate Sulphate of Potash Lime.	16 Nov. 1911 18 Nov. 1911 28 Nov. 1911 28 Sept. 1911	30 Dec. 1913 31 Dec. 1913 2 Jan. 1914 15 Oct. 1913	2'15 ins 7'28 ins Oct. 1911	11'04 ins 18'00 ins Oct. 1912	26'43 ins 5'13 ins Oct. 1913	3'76 ins. 6'96 ins. Oct. 1914	8'43 ins.			
4	Sulphate of Ammonia Sulphate of Potash Lime.	16 Nov. 1911 28 Nov. 1911 2 Oct. 1911	30 Dec. 1913 2 Jan. 1914 15 Oct. 1913	2'12 ins 6'13 ins Oct. 1911	9'94 ins 15'91 ins Oct. 1912	23'67 ins 4'01 ins. Oct. 1913	3'81 ins. 5'97 ins. Oct. 1914	7'76 ins.			
5	Double Superphosphate Sulphate of Potash Lime.	18 Nov. 1911 29 Nov. 1911 2 Oct. 1911	31 Dec. 1913 2 Jan. 1914 15 Oct. 1913	2'01 ins 6'66 ins Oct. 1911	10'94 ins 17'30 ins Oct. 1912	24'12 ins 4'65 ins. Oct. 1913	4'28 ins. 6'26 ins. Oct. 1914	6'92 ins.			
6	No Manure.			2'35 ins 5'13 ins Oct. 1911	8'30 ins 14'33 ins Oct. 1912	23'09 ins 2'78 ins. Oct. 1913	3'77 ins. 5'43 ins. Oct. 1914	8'76 ins.			

Rate of application:— Sulphate of Ammonia $\frac{1}{2}$ lb. per tree
Double Superphosphate $1\frac{1}{2}$ lbs. per tree.

Sulphate of Potash 1 lb. per tree
Lime 1,000 lbs. per acre.

TABLE B.
No of Trees in Each Plot, 100.

No. of Plot.	Manure applied.	Date of applying manure 1st application.	Date of applying manure 2nd application.	Average girth 1 foot from the ground.								Increase in girth.			
				1st year.	2nd year.	3rd year.	4th year.								
7	Sulphate of Potash Lime.	29 Nov. 1911 6 Oct. 1911	2 Jan. 1914 19 Oct. 1913	2'96 ins. 1911	7'77 ins. 1912	11'63 ins. 1913	18'2 ins. 1914	25'48 ins. 1915	4'81 ins.	3'86 ins.	6'57 ins.	7'28 ins.			
8	Double Superphosphate Lime.	19 Nov. 1911 9 Oct. 1911	31 Dec. 1913 19 Oct. 1913	2'44 ins. 1911	8'00 ins. 1912	11'88 ins. 1913	18'09 ins. 1914	25'12 ins. 1915	5'56 ins.	3'88 ins.	6'21 ins.	7'03 ins.			
9	Lime.	13 Oct. 1911	19 Oct. 1913	2'73 ins. 1911	7'47 ins. 1912	10'51 ins. 1913	17'18 ins. 1914	24'95 ins. 1915	4'74 ins.	3'04 ins.	6'67 ins.	7'77 ins.			
10	Perlis Guano.	30 Nov. 1911	3 Jan. 1914	2'72 ins. 1911	7'65 ins. 1912	11'21 ins. 1913	17'78 ins. 1914	25'39 ins. 1915	4'93 ins.	3'56 ins.	6'57 ins.	7'61 ins.			
11	Bone Meal.	30 Nov. 1911	3 Jan. 1914	3'11 ins. 1911	8'47 ins. 1912	12'79 ins. 1913	19'21 ins. 1914	26'30 ins. 1915	5'36 ins.	4'32 ins.	6'42 ins.	7'09 ins.			
12	Sulphate of Ammonia Double Superphosphate Sulphate of Potash.	13 Nov. 1911 30 Nov. 1911	30 Dec. 1913 2 Jan. 1914	8'02 ins. 1911	8'19 ins. 1912	11'96 ins. 1913	18'03 ins. 1914	25'82 ins. 1915	5'17 ins.	3'77 ins.	6'07 ins.	7'79 ins.			
13	No Manure.			2'71 ins. 1911	6'40 ins. 1912	10'02 ins. 1913	16'39 ins. 1914	23'85 ins. 1915	3'69 ins.	3'62 ins.	6'37 ins.	7'46 ins.			

Rate of application:— Sulphate of Potash 1 lb. per tree.
Double Superphosphate 1½ lbs. per tree.
Perlis Guano 4 lbs. per tree.

Bone Meal 3 lbs. per tree.
Sulphate of Ammonia ½ lb. per tree.
Lime 1,000 lbs. per acre.

Notes on some fungus diseases of coffee in Malaya.

BY W. N. C. BELGRAVE.

These notes record observations made during the past year. Owing to the limited and diminishing area under coffee, and to the lightness of attacks by any of the diseases, it was not thought that the time spent in a full investigation would be repaid. They may however be useful in the future, as a basis for further work.

LEAF DISEASES.

The most wide-spread coffee leaf disease—"Leaf spot" occurs locally, but not to any serious extent. The fungus causing it, *Hemilea vastatrix* belongs to that large and destructive family, the Uredineae, or "rusts." Unlike many members of the family, *Hemilea* passes the whole of its life-history on one host—viz. Coffee; this greatly simplifies control methods. The first sign of attack is the formation of small circular, yellowish, translucent, spots on the leaf, rapidly followed by the production on the under-side of an orange-yellow powder—the spores. These spores are borne on the end of stalks extruded from the stomata or breathing pores, and are oval, averaging 30 by 40 microns, with fairly thick walls studded with spines. They are distributed by the wind, and falling on a healthy leaf, given the right conditions of moisture, germinate. The germ-tubes then enter the leaf through the stomata, and grow inside, deriving nutriment from, and killing the cells of the leaf.

Invariably on mature *Hemilea* spots, a fine glistening white web is seen. This on examination proves to be the mycelium of a fungus, with branched conidiophores on which are borne continuous hyaline spores—conidia—averaging 2×6 microns, aggregated into "heads." These characters indicate a member of either of the genera *Hyalopus* or *Cephalosporium*. Members of both genera are known to be parasitic on higher fungi, and it is possible that this fungus acts as a control to *Hemilea*. It is certain that *Hemilea* spots never spread, and rarely is even a single leaf killed by the rust.

LEAF SCORCH.

On leaves suffering from "Scorch," large areas become brown, withered and hard. Later, small black pustules about the size of a pin's head develop. These are the pycnidia of two different fungi—one *Phyllosticta coffeicola*, with colourless unicellular oval spores, averaging 3 by 1.5 microns; the other *Coniothyrium coffeae*, with dark-coloured, round, unicellular spores 2-3 microns diameter. The

spores from both pycnidia, are extruded, and are doubtless wind-borne. Zimmermann (Eenige Pathologische en Physiologische waarnemingen over koffie. Meddeelingen uit 'Slands Plantentuin 67) states that he has never seen *Coniothyrium* on a leaf unaffected by *Hemilea*—here in Malaya however, the fungus seems able to attack healthy leaves.

Another fungus—*Collectotrichum* sometimes occurs on the leaves, but is more frequent on the stem, and will be described below.

At present none of these diseases are serious enough to warrant treatment, should they increase, spraying with any of the approved mixtures should be successful.

As is the case with many other crops, leaves are often observed prematurely to wither and turn yellow in the absence of any disease or pest. The cause of this must be looked for in unfavourable weather or soil conditions. Among the latter may be reckoned excessive manuring, particularly with nitrogenous manure. This however, is not likely to be a determining factor locally.

STEM DISEASES.

These are at present of no economic importance. A certain number of small branches suffer from "die-back," but the disease never spreads into the larger branches or main stem.

Sections of diseased branches show abundant hyphae in the wood and bark and on keeping in a saturated atmosphere fruit bodies of two fungi develop.

(A) Large hairy pustules—pycnidia—sunk in the bark from which enormous numbers of large oval colourless spores are extruded bound together by mucilage into pinkish yellow tendrils. Although when extruded, these spores are unicellular, before germination they become 1-septate. A smaller number of dark 2-celled spores 20 by 7 microns are also produced, showing the fungus to be a member of the Genus *Diplodia*. (The hairy pycnidia would indicate *Chaetodiplodia* but Taubenhaus—Am. Journ. Bot. Vol. 2, No. 7—has brought forward strong reasons for regarding the genera *Chaetodiplodia*, *Botryodiplodia*, etc. as non-valid).

(B) Patches of long black bristles, among which are found hyaline, unicellular spores 15 x 5 microns—characteristic of the genus *Collectotrichum*, a very common fungus locally. In culture black spore-like bodies are produced on the hyphae, similar to those figured by Stevens for *C. Carica*. ("The fungi which cause plant disease" p. 549). Preventive measures are, cutting out and burning diseased branches, but at present this is not necessary.

ROOT DISEASES.

Only one has been observed. A white felt-like mycelium was found growing between the wood and bark, and there was a well marked brown line between healthy and diseased tissue—the dead wood remained hard and firm. Zimmermann (Loc. cit.) describes a very similar disease under the name of “White root disease.” He has never found the fructifications, but the mycelial characters are those of the higher fungi—the Basidiomycetes. It is of very slow growth, and according to Zimmermann supplies are unaffected. It would however; be a wise precaution if the spot were first limed.

FRUIT DISEASES.

Berries, particularly of “robusta,” showing grey spots or patches are of very common occurrence, but the most careful search has failed to bring to light any fungus or insect agent; this was also Zimmermann’s experience (Loc. cit.). These spots are of no importance in themselves as the seeds are unaffected but the epidermis may dry up and split, opening the way for other harmful fungi. They are invariably on the exposed side of the berry, and so cannot be due to abrasion from the other fruits in a cluster; more likely as Zimmermann suggests they are caused by unfavourable weather conditions. When young, scale insects are very often found on the berries, and associated with them is a black “Sooty-mould” fungus belonging to *Capnodium* or an allied genus. This lives on the secretions of the scale-insects and is harmless, except in so far as the cutting off of light from the young berries may affect their development. Sometimes on unhealthy looking berries small pycnidia are produced, bearing spores very similar to those of the *Coniothyrium* described above.

In other cases on raised patches little black dots appear, on which dark coloured, 3 to 4-septate spores, measuring 24 x 5 microns, and with branched bristles at one end are found—these are the spores of *Pestalozzia Coffeae* a fungus very similar to the well known enemy of cocoanuts.

A few cases of *Hemilea* attacking “Liberia” fruits have been observed.

None of these fruit diseases is likely ever to become serious.

When berries for any reason die, they become covered with several Saprophytic fungi, chiefly *Stilbum* and *Fusarium* species. These seem unable to infect healthy fruits.

It will be obvious that coffee in Malaya enjoys almost complete immunity from serious fungus diseases; this satisfactory state of affairs is unlikely to alter provided reasonable attention be given to general sanitation on the limited areas still under this crop.

Some Johore Soils.

BY J. GRANTHAM.

During the past few months considerable time has been devoted to a study of the soils of Johore. Widely varying types have been found and some of these are of considerable interest as demonstrating the presence of well marked limiting factors.

The soils have been collected from three well defined areas. (1) The Johore Bharu district (2) Muar district (3) Batu Anam district.

THE JOHORE BHARU SOILS.

The soils in this district are all of one general type viz. a loose yellow sandy soil. The ground is gently undulating but owing to the loose nature of the soil, suffers greatly from wash. The greater part of the land has been under cultivation for many years being planted up with pepper and gambier, which were subsequently supplanted by pineapples, and finally rubber. The analyses of five typical soils are given below; all were taken from land under rubber, and 2, 3 and 5 and possibly 4 had been previously cultivated for many years.

MECHANICAL ANALYSIS.

		1.	2.	3.	4.	5.
Coarse sand	percent.	33.2	42.4	39.4	33.8	40.9
Fine sand	"	8.0	11.4	10.5	15.1	11.2
Coarse silt	"	4.0	4.5	6.3	2.6	3.6
Fine silt	"	11.7	6.7	8.9	7.7	11.4
Clay	"	28.0	23.6	23.6	27.9	20.4
Moisture	"	2.3	2.3	2.1	2.5	1.4
Loss on ignition = organic matter + combined water	"	7.9	7.2	7.0	10.0	11.1
Lost during analysis	"	4.9	1.9	2.2	.4	—
		100.0	100.0	100.0	100.0	100.0

CHEMICAL ANALYSIS.

Nitrogen	percent.	.133	.091	.084	.132	.114
Potash (total)	"	.072	.047	.145	.038	.129
Phosphate (total)	"	.006	.064	.084	.036	.016
Insoluble in Hydrochloric acid	"	69.0	76.0	68.0	69.0	75.0
Lime requirement	"	.26	.169	.2	.3	—

Lime requirement, tons
per acre to neutral-
ise acidity to depth
of 1 foot

„ 3½ 2½ 3½ 4.0 —

It will be seen from the above figures that the variation in texture between these soils is very small. They are characterised by a high percentage of coarse sand and a moderate amount of clay with comparatively low percentages of the intermediate fractions. The chief characteristic of these soils is their poverty in both potash and phosphate. The nitrogen content is low but sufficient for rubber. The acidity for soils of this type is distinctly high. The poverty of the soils is no doubt partly due to the length of time during which they have been cultivated and partly to the excessive wash. The first measure to be adopted in improving soils of this type is to increase the humus content. This can only be carried out on a large scale by green manuring. Bullock manure is known to give excellent results, but is of course only available in limited quantity.

THE MUAR SOILS.

The soils of the Muar district, all of which were taken from flat land, are very variable in type. The samples were taken in two groups, one group from the rubber estates up river and the other from native coconut holdings at Parit Jamil south of Muar.

The rubber soils showed four distinct types, heavy clay (samples 1, 2, 3 and 4), white sand (sample 5), peat (sample 6) and laterite. The planted area on laterite was small in extent and was not sampled. Following is a detailed description of the soils from which the samples were taken.

1. A very stiff sticky and wet white clay. The rubber is eleven years old and although in growth is not striking, gives a yield of 450-475 lbs. per annum.

2. From a very much stiffer patch found in the above soil, on which the rubber refuses to develop.

3. A somewhat less stiff clay on which the growth of the four year old trees is excellent.

4. Another very stiff clay similar to 1 giving a yield of 450-500 lbs. from old trees.

5. A white sand containing but little humus. Full of a tangled mass of fibrous rubber roots. The growth is very poor and the bark renewal bad. Here and there in this soil pockets of clay are to be found on which the growth is much better (sample 5 C).

6. From a peaty area giving good growth and yield.

The mechanical analysis of these samples were:—

These figures show the enormous variation in the soil which occurs in a restricted locality. They are chiefly interesting in showing the limits of mechanical texture between which rubber can be successfully grown. The extremely stiff soils (1) and (4) are yet good rubber soils but when the clay percentage rises to 44 combined with practically nothing else but fine silt as in (2) the limit is passed and the rubber does not develop. Sample (5) shows the other extreme, that of a soil too light for rubber.

Judging by the growth alone (3) should be the best of these soils for rubber.

CHEMICAL ANALYSIS.

	A = Top soil.						B = Subsoil.				
	1A.	1B.	2.	3.	4A.	4B.	5A.	5B.	5C.	6A.	6B.
Insoluble in Hydrochloric acid	percent. 74.0	72.0	68.0	72.0	66.0	79.0	88.0	95.0	70.0	62.0	69.0
Nitrogen	.178	.168	.212	.158	.268	.220	.128	.052	.021	.657	.312
Phosphate (total)	.060	.055	.025	.064	.065	.035	.038	.036	.050	.076	.056
Potash (total)	.163	.461	.609	.450	.061	.069	.086	.091	.241	.071	.234
Lime requirement	acid.	acid.	acid.	acid.	.450	—	.305	—	—	.504	—
Lime requirements tons per acre to neutralise acid in 1 foot of soil	—	—	—	—	6.0	—	4.0	—	—	6.7	—

Compared with the mechanical analyses, the chemical analyses have little to show. The percentage insoluble in hydrochloric acid merely reflects the mechanical composition, being high in the light soil and low in the clays. The nitrogen is low in the sand which contains little organic matter and high in the peat which contains much. The

phosphate as in nearly all Malayan soils is low throughout. The potash determination reveals one interesting fact, viz. the low potash content of such a heavy clay as 4 shows it to be mainly derived from a soda felspar and not a potash one as in the case of 1, 2 and 3.

The coconut soils of Parit Jamil include some of the finest coconut land in the country. Being all native holdings no reliable statistics are available as to exact yields, but many of the trees may be seen bearing 60 or more full size nuts besides growing bunches. The soils in this district are all peaty.

1. From the best land. 1 mile inland. The surface soil is black to a depth of 6" to 12" and the subsoil is clay.

2. From good land. 3 miles inland not quite equal to 1. A little more peaty.

3. From poor land 5 miles inland, a pure peat soil.

MECHANICAL ANALYSIS.

		1	2	3
Coarse sand	percent.	.8	.2	peat soil.
Fine sand	"	1.6	.3	
Coarse silt	"	2.5	.5	
Fine silt	"	24.3	32.5	
Clay	"	37.5	25.6	
Moisture	"	5.7	4.3	15.7
Loss on ignition = organic + combined water	"	27.6	30.7	71.4
Lost during analysis	"	—	5.9	
		100.0	100.0	

CHEMICAL ANALYSIS.

Insoluble in hydrochloric acid	percent.	.58	.54	.12
Potash (total)	"	.510	.242	.077
Phosphate (total)	"	.073	.122	.074
Nitrogen	"	2.7	2.67	5.52
Lime requirement	"	.835	.605	1.535
Lime requirement tons per acre to neutralise 1st foot of soil	"	11.2	8.1	20.5

Chemically the most noticeable feature of these soils is the very small potash content of 3 which is unusual for a peat. The high loss on ignition and high lime requirement demonstrate its lack of mineral matter and high acidity to which its poverty must be attributed. The superiority of 1 is due to its excellent tex-

ture, sufficient clay being present to ameliorate the peat which itself is quite rich in plant food. This soil can be taken as a typical example of a good coconut soil.

THE BATU ANAM SOILS.

These soils were all taken from bukit land under rubber. They show a fair degree of variation but much less than those of the Muar district. They constitute a type quite different from the other districts examined, and resemble generally the other bukit soils of Malaya. The general types found are a yellow loamy soil forming a large part of the district, with patches of laterite at intervals, a whitish clay, a dark red hill soil, and a whitish very close textured soil occurring in flats formed by wash from the bukit soils.

The samples taken were as follows:—

1. From the yellow loamy soil. Growth and appearance very good. Planted from virgin jungle.
2. Similar to 1.
3. From a gully formed from the wash of No. 2. Growth and yield poor. Drainage insufficient. Planted from lalang.
4. From an extensive flat formed from the wash of 2 but better drained. Very close texture. Roots all on the surface. Planted from lalang.
5. A laterite soil, subsoil similar to 1. Planted from virgin jungle.
6. A red hill soil. This soil has a peculiarly intense red colour. The growth and yield are excellent.
7. A whitish clay. Growth and yield similar to 1.

MECHANICAL ANALYSIS.

	A = Top soil.					B = Subsoil.				
	1A.	1B.	2.	3.	4.	5A.	5B.	6.	7A.	7B.
Coarse sand	27.6	27.3	29.4	.2	2.3	34.5	33.6	7.4	11.7	8.4
Fine sand	23.2	21.1	23.1	33.8	46.9	23.8	23.9	6.2	17.7	15.3
Coarse silt	14.1	12.9	7.3	15.5	3.5	12.8	14.0	.1	14.7	9.8
Fine silt	18.6	18.6	12.6	28.1	27.6	14.3	15.5	10.5	30.9	34.9
Clay	41.3	14.5	11.7	15.6	12.1	9.1	7.8	55.7	18.6	25.4
Moisture	.9	1.1	1.1	1.4	1.6	.9	.8	3.9	1.2	1.2
Loss on ignition	4.0	4.1	3.5	4.0	4.9	4.6	4.3	14.1	4.6	4.5
Lost during analysis	.3	.4	1.3	1.4	1.1	—	.1	2.1	.6	.5
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

CHEMICAL ANALYSIS.

	88.0	86.0	88.0	88.0	86.0	81.0	82.0	46.0	87.0	85.0
Insoluble in hydrochloric acid	percent.									
Potash (K_2O) total	.245	.258	.154	.193	.145	.295	.206	.710	.493	.522
Phosphate (P_2O_5) total	.033	.027	.037	.033	.017	.034	.039	.198	.033	.028
Nitrogen	.126	—	.058	.095	.112	.344	—	.186	.086	—
Lime requirement	.094	—	.124	.164	.165	.117	—	.224	.101	—
Lime requirement tons per acre (approx) to neutralise 1st foot of soil	1.2	—	1.6	2.1	2.2	1.5	—	3.0	1.3	—

The similarity in mechanical type between 1 and 2 is at once evident. 3 and 4 which are derived by wash from soils of the type 1 and 2 show, as would be expected, a great diminution in the coarser particles. 5 is similar to 1 and 2 but its content of laterite gives it a greater percentage of coarser particles. All these soils are thus related and it may be said in general of this district that the laterite type 5 is found on the hill tops, types 3 and 4 in the valley flats, while the greater part of the remainder is represented by the types 1 and 2. Chemically these soils resemble one another. The phosphate content as usual is very low.

The remaining two soils 6 and 7 are distinct types, 7 is a close textured heavy soil containing a large percentage of fine silt, and a high percentage of potash. The most interesting soil is however 6 the red hill soil. This soil is of a somewhat unusual type. It is by no means such a stiff soil as such a high percentage of clay as 55% usually indicates. It is soluble in hydrochloric acid to an extraordinary extent for a soil containing no peat, and is very rich in potash, and phosphate and nitrogen.

Departmental Note.

Bulletin No. 1.—Notes on *Termes Gestroi* and other species of Termites found on Rubber estates in the Federated Malay States, by H. C. Pratt, has been reprinted, and copies can now be obtained at the usual rate.

Mr. H. C. Pratt Govt. Entomologist resigned his post on 8th January, 1916.

Exports of Rubber from British Malaya, (other than the F. M. S.)

State.	Month.	Quantity.
Johore	October to November, 1915.	lbs. 4,164,746
Kelantan	October to November, 1915.	lbs. 211,427
Kedah	July to November, 1915	lbs. 2,145,350
Perlis	—	—
British N. Borneo	October, to November, 1915.	lbs. 499,634
Brunei	September to November, 1915.	lbs. 26,416

FEDERATED MALAY STATES.

*Comparative Statement of Cultivated Rubber Exported, with Value and Duty Collected Thereon,
During the Years 1915 and 1914.*

Destination.	Exported during November, 1915.	Previously.	Total export during the year.	Export during similar period of previous year.	Increase. Decrease.	Value of rubber ex- ported, 1915.	Duty collected, 1915, to date.
	Tons.	Tons.	Tons.	Tons.	Tons.	\$	\$ c.
Straits Settlements ...	3,495.24	23,397.65	26,892.89	16,050.46	10,842.43	49,418,418	
United Kingdom ...	1,045.91	10,730.73	11,776.64	9,746.81	2,029.83	23,515,841	
Continent of Europe ...	...	8.00	8.00	807.78	799.78	15,880	
Ceylon ...	73.33	545.75	619.08	630.89	11.81	1,237,553	
Other Countries ...	21.04	95.07	116.11	100.27	15.84	226,575	
Total ...	4,635.52	34,777.20	39,412.72	27,336.21	12,888.10	74,414,267	2,037,074 57

KUALA LUMPUR,

6th December, 1915.

E. BURNSIDE,
Acting Commissioner, Trade and Customs, F.M.S.

